

IPO Trading without Market Makers

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Abstract

We investigate the trading and liquidity supply of IPOs in order-driven markets with pure limit order books, where no market makers exist and no market orders are allowed. We find large trades dominate the first day of trading and are positively related to underpricing, but this pattern quickly reverses as small trades dominate subsequent trading days and become negatively related to underpricing. Similarly, quoted depths are large on the first day, but drop precipitously in subsequent days and are positively related to offer size and negatively to underpricing. We find transaction immediacy is positively related to underpricing. To obtain trade immediacy, investors submit aggressive limit orders that are better than the best quotes in the opposite of limit order book. Order imbalance reveals important information about IPO investors' buy and sell interests and affects trade aggressiveness. When order imbalance is large and positive (negative), IPO investors buy (sell) more aggressively. Finally, when spreads are tight, investors trade more aggressively.

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I. Introduction

Creating a liquid secondary market is crucial for firms going public. In a quote driven market, like the U.S. Nasdaq stock market, market makers are the major liquidity suppliers. Although dealers in a quote-driven market have the freedom of choosing when to start or stop making a market in a particular security, the growing literature has shown that underwriters providing investment banking services play a pivotal role in the early aftermarket trading of IPOs.

A recent survey of company CFOs by Brau and Fawcett (2006) indicates that an underwriters' market making and trading desk services in the IPO aftermarket are key elements in issuing firms' underwriter selection. Recent empirical evidence supports this vital function of underwriters' market making services. Ellis, Michaely, and O'Hara (2000, 2002) find that the lead underwriters of Nasdaq IPOs always become market makers and are the dominant dealers. These dealers handle more than 60% of IPO trading in the early IPO aftermarket. Schultz and Zaman (1994) find that underwriters spend a large proportion of their time at the inside bid for cold IPOs and stand ready to buy back newly issued shares if demand is weak. Aggarwal (2000) further shows underwriters offer active price support using over-allotment options, short covering, and penalty bids in the IPO aftermarket. For NYSE IPOs, in which a specialist system prevents underwriters from participating as a market maker, Corwin, Harris, and Lipson (2004) find that underwriters continue to play a vital role in IPOs by providing price support through the trading floor.

To the extent that lead underwriter-dealers play a dominant role in the IPO aftermarket trading in quote-driven markets, it is far less clear how IPOs are traded and how liquidity imbalance is restored without the intervention of lead underwriter-dealers. In order-driven markets, no market makers exist and therefore underwriters play no role in IPO aftermarket trading. Liquidity in order-driven markets is entirely supplied by public investors through limit

order submissions. More importantly, in order-driven markets, there is no party who is obligated to provide liquidity. Given the extraordinary active trading event of an IPO and the growing popularity of electronic order-driven markets around the world, it is critical to understand the dynamics of trading and liquidity provision for new issues in these markets where execution immediacy is greatly desired, but no designated party is responsible for doing so. We are the first paper to empirically examine these important issues.

In this paper, we analyze the trading, liquidity supply and evolution of liquidity in a novel sample of 506 Chinese IPOs from August 1999 to December 2005. First, China not only represents the largest order-driven market in the emerging economies, but initial returns for Chinese IPOs are the highest in the world.¹ In such a market characterized by a high level of aggregate demand uncertainty, liquidity is of utmost importance. Second, underwriters in China are not allowed to offer price support in the IPO aftermarket (Xiong and Meng, 2007). Thus, this sample allows us to investigate how liquidity imbalance is restored when no party is obligated to provide it. Third, Chinese stock markets do not allow investors to submit market orders during our test period. Therefore, we are able to examine liquidity issues solely through limit order submissions without the inevitable endogeneity problem of order submission choice.

We have several important findings. First, large trades dominate the first day of trading in all IPOs, and this dominant role is more pronounced in large and high initial return IPOs. However, after the first day, this pattern is reversed. Small trades dominate trading in all IPOs and this dominant role is more pronounced in small offerings and low initial return IPOs. Trading converges to a stable level after about 10 trading days.

Second, quoted depths in the limit order book mimic the pattern of IPO aftermarket trading. That is, quoted depths are extremely high on the first day and decline sharply after the first few days. They are positively related to offer size and negatively related to the first day

¹ See the updated data and table (March 2007) of Loughran, Ritter, and Rydqvist (1994) by Jay Ritter: <http://bear.cba.ufl.edu/ritter/Int2007.pdf>.

return. Quoted spreads are also larger for large trades and this relation remains significant after controlling for offer size and initial return. These results suggest that information asymmetry is severe for small and high initial return IPOs.

Third, the thickness of limit order book reveals important information to IPO investors and has a significant effect on trade aggressiveness. When the book on the bid side is much thinner than the ask side (i.e., negative share imbalance), incoming sellers submit aggressive marketable limit orders by quoting ask prices below the best bid to secure immediate execution. In contrast, when the book on the ask side is substantially thinner than the book on bid side, a signal of strong buying interest, buyers aggressively submit orders with bid prices higher than the best ask quote existing in the limit order book to lock-in immediate transactions. Thus, when market participants observe a severe share imbalance in the limit order book, immediacy is paramount and trades become increasingly more aggressive.

This paper contributes to the literature in at least two ways. First, although the growing popularity of order-driven markets has attracted increased attention in the literature, previous studies on order-driven markets exclusively focus on stocks with a long trading history and where investors can submit both market and limit orders.² To our knowledge, this is the first paper providing empirical evidence on IPO trading and liquidity provision in pure order-driven markets where no market orders exist. Since no designated market makers exist, immediacy is very important for IPO investors in aftermarket trading when price movement is rapid. The fierce competition on the buy side, which is measured by a large order imbalance, makes impatient buyers to pay prices higher than the best ask price to secure immediate trade. At the same time, the “crowding out” effect suggested by Parlous (1998) induces potential sellers to submit limit sell-orders because of the economic benefits of higher ask prices and the increased probability of

² For example, Biais, Hillion, and Spatt (1995) and Handa, Schwartz, and Tiwari (2003) use 40 stocks in the CAC 40 index from Paris Bourse in their studies. Sandas (2001) employs 10 most actively stocks traded at the Stockholm Stock Exchange. Ahn, Bae, and Chan (2001) use 33 component stocks in the Hang Seng Index from the Stock Exchange of Hong Kong.

limit order execution. Consequently, share imbalance is reduced, and buys and sells restore to equilibrium. Symmetric conditions hold for more intensive competition on the sell side.

In the case of IPO trading in a quote driven market, the literature shows that lead underwriters provide price improvement to encourage large buy orders from customers for cold IPOs (Ellis 2006). Our finding suggests that in an order driven market, urgent traders are willing to pay more for the consumption of scarce liquidity, which must be provided by patient traders to the thinner side of the book.

Second, our evidence provides an improved understanding on the dynamics of how liquidity is restored when buy and sell imbalance occurs in an order-driven market. Third, we show the evolution of liquidity from the initial trade through the first several days of trading and the process by which trading ultimately stabilizes.

The rest of this paper will proceed as follows. Section II discusses the mechanics of the trading system in China, the data used in this study, and the sample selection procedure. Section III provides empirical results while Section IV concludes.

II. Background Information, Data, and Sample Selection

A. Trading System of Chinese Stock Markets

The two Chinese stock markets, the Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE), operate in an order-driven environment with electronic consolidated open limit order books (COLOBs). The exchanges are open 5 days a week except for public holidays. The market opening is based on a consolidated call auction from 9:15am to 9:25am. The morning session begins at 9:30 and trading continues until 11:30 when the markets close for a lunch break until 1:00. The afternoon session at the SHSE is from 1:00 to 3:00 with a continuous auction whereas at the SZSE, trading ends at 2:57 and a closing call auction is held from 2:57 to 3:00.

Trading rules for SHSE and SZSE are identical with a few minor differences.³ Investors need to open securities & cash accounts and sign broker-client agreements with a member designated by the exchanges. Once such an agreement is signed, investors instruct the designated member to trade securities on their behalf. The designated member routes client orders to the exchange's trading system based on the order of acceptance of client instruction. Orders entered in the COLOB are automatically matched and executed based on a price-time priority principle. One important feature distinguishing the Chinese trading system from other order-driven markets is that investors can submit only limit orders before July 1, 2006.⁴

B. Data and Sample Selection

We collect IPO information and intra-day quote and trade data from China Center for Economic Research (CCER), which is one of the major suppliers of Chinese financial market data. The intraday quote and trade database compiled by CCER provides detailed information for each trade, including trade time, transaction price, trading volume, a buy and sell flag, the five highest bid prices and the number of shares at each bid price, and the five lowest ask prices and the number of shares at each ask price associated with each trade.

Our initial sample includes all 508 IPOs (A-shares) listed on the SHSE and SZSE from August 1999 to December 2005. The earliest available date for the trade and quote data from CCER is August 1999. We cut off our IPOs in December 2005 to avoid the effects of the stock

³ See the official website of SHSE at http://www.sse.com.cn/sseportal/en_us/ps/home.shtml, and the official website of SZSE at <http://www.szse.cn/main/en/> for details.

⁴ Since July 1, 2006, investors can submit both limit orders and market orders. However, market orders are not popular among investors and exchange members. Several restrictions are applied on market orders. On SHSE, only two types of market orders are allowed: (1) Five Best Orders Immediate or Cancel, and (2) Five Best Orders Immediate to Limit. On SZSE, in addition to Five Best Orders Immediate or Cancel order, there are four other market orders: (1) Counterparty Best Price order; (2) Same Side Best Price order; (3) Immediate or Cancel order; and (4) Fill or Kill order.

market reforms carried out in China in 2006.⁵ We eliminate two IPOs because of apparent data errors. The final sample includes 506 IPOs.

Offering and firm statistics of the 506 IPOs are reported in Table 1 of Panel A. The average offer price is 8.0 Reminbi (RMB, Chinese currency) per share, ranging from RMB 1 to RMB 36.7, with a median price of RMB 7.2. The average number of shares offered is 101 million with the average number of shares available in circulation of 83 million. The average offer ratio, the number of shares offered divided by the number of shares demanded by investors through lottery, is 0.4 percent, indicating strong market demand for IPOs in China. The average number of shares outstanding before IPO is 460 million, and the average number of shares held by the state government is 364 million. The IPO invitation and share subscription begin 28.1 days prior to the offer date and last for 11.2 days, on average. The earliest invitation begins 213 days prior to the offering day, and the longest invitation period lasts for 92 days.

The first day opening return, computed as the percentage difference between the first day opening price and the offer price is 121 percent, on average, with a median of 100 percent. The first day closing return, relative to the first day closing price, is 124 percent, on average. This implies that the majority of the underpricing return accrues to investors allocated shares at the offer price and is revealed immediately when trading begins. These results are consistent with previous studies.⁶

In Panel B of Table 1, we present aftermarket trade and quote summary statistics. On the first day of trading, average volume is about 38 million shares, dropping to approximately 6 million shares on days 2 through 10. Likewise, the average trade size is 88,700 on the first day of

⁵ On April 29, 2005, the China Securities Regulatory Commission (CSRC) announced a stock market reform program, which involved transformation of non-tradable shares into tradable shares for existing companies. Majority of the companies completed their reforms during the period 2006 and 2007. The first IPO with 100% tradable shares, China CAMC Engineering Co., Ltd., was listed in 2006.

⁶ For example, Su and Fleisher (1999) show that the average first day return is 948.6% for the Chinese IPOs from 1987 to 1995. Chan, Wang, and Wei (2004) find that the average first day return of A-share IPOs is 178% from 1993 to 1998. Tian and Megginson (2007) find that the first day return declines from 1,450.3% in 1992 to 71.1% in 2004.

trading, falling to 9,300 on days 2 through 10. Quoted depths are also higher on the first day of trading at 6,326 shares, compared to 3,229 shares on days 2 through 10. Finally, spreads average about 2.2 percent on both the first day of trading and subsequent 9 trading days.⁷

III. Empirical Results

To reduce the effects of possible data error and outliers, we eliminate observations if: (1) the highest bid price or the lowest ask price equals zero; (2) the absolute value of the bid and ask spread is larger than 50% of the current transaction price; (3) the absolute value of the bid and ask spread is greater than 50% of the midpoint of the highest bid and the lowest ask prices; and (4) trades and quotes occur during the pre-opening call auction session (before 9:25am).

A. Effects of Offer Size and Initial Return on Trade and Liquidity Measures

Previous studies suggest that Chinese investors have a less elastic demand curve for stocks because of limited investment opportunities (Stulz and Wasserfallen (1995) and Sun and Tong (2000)). Therefore, we conjecture that the number of shares offered in IPOs could affect investors' trade and liquidity supply behavior in the IPO aftermarket. In addition, given the fact that the number of shares offered account for only about 0.4 percent of the total shares demanded by investors (see Table 1), the first day opening return could be an important factor affecting investors' IPO trading. To begin our analyses, we provide univariate cuts of our data based on offer size and initial returns in Panels A and B of Table 2, respectively.

In Panel A, IPO firms are grouped into small ($x \leq 40,000$), medium ($40,000 < x \leq 60,000$) and large ($x > 60,000$) based on the number of shares offered in the IPO. Each group has approximately the same number of observations. Similarly, each trade is grouped according size:

⁷ We chose to average days 2 to 10 because by around the tenth trading day, trade activity and liquidity converged to a stable level.

small ($x \leq 10,000$), medium ($10,000 < x \leq 50,000$), and large ($x > 50,000$). For the first and subsequent nine trading days (days 2 through 10), we investigate volume-to-offer size ratios, quoted depths, and quoted spreads based on this sort.

Focusing on the volume-to-offer size ratio on day 1, there is an increasing pattern as the average trade size increases for all offer size groups.⁸ For instance, for small offerings, the volume-to-offer size ratio is 9.4 percent for small trades, increasing to 23.1 percent for large trades. A similar pattern holds for medium and large offerings. However, this pattern reverses on days 2 through 10 and a decreasing relationship between trade size and the volume-to-offer size ratio is observed. For example, in small offerings, the volume-to-offer size ratio is about 4.0 percent for small trades, decreasing to 0.7 percent for large trades. In all cases, day 1 has a significantly higher volume-to-offer size ratio compared to days 2 through 10 with the exception of small trades for large offerings. Thus, large trades take the dominant role of IPO trading on the first day, but small trades are predominant thereafter. The dominant role of large trades on day 1 possibly implies active trading by more informed investors.

The next three rows in Panel A of Table 2 provide information on quoted depths. Not surprisingly, quoted depths appear to be increasing in offer size, implying greater liquidity is available for larger offerings. Alternatively, since offer size can be interpreted as a measure of asymmetric information, the positive relation between depths and offer size implies that investors are willing to provide more liquidity when the degree of information asymmetry is lower. For instance, if we hold trade size constant, quoted depths increase from 1.4 million shares for small offerings to 3.6 million shares for large offerings. Note also that, holding offering size constant, depths increase in trade size. This is understandable since investors need to quote more shares if they want to execute larger trades because market orders are not allowed. Further, in all

⁸ We also use the number of shares available for circulation in computing the volume-to-offer ratios and observe similar results. For brevity, the results based on the number of shares available for circulation are not reported, but available from the authors upon request.

categories, quoted depths are significantly larger on the first day of trading than for days 2 through 10. In subsequent analyses, we investigate bid and ask depth separately.

The final three rows of Panel A provide information on quoted spreads.⁹ Spreads appear to be increasing in trade size, but decreasing in offer size. For small offerings on day 1, quoted spreads for small trades average 0.018 RMB increasing to 0.052 RMB for large trades suggesting that large trades consume liquidity. Alternatively, the large spreads associated with large trades could suggest that traders engaging in large trades are informed investors. However, if we examine small trades only, spreads decline monotonically from 0.018 for small offerings to 0.013 for large offerings. Large offerings have more shares available for trade and more public information available to investors and thus the cost of liquidity consumption is lower and information asymmetry is less severe. A similar pattern is present for medium and large offerings. In comparing day 1 to days 2 through 10, we find mixed results. In three cases, spreads are smaller on the first day, but in four categories, spreads are larger on the first day. Overall, there does not seem to be a clearly evident pattern between the evolution of trading and spreads.

In Panel B of Table 2, we investigate the relationship between underpricing (i.e., the 1st day opening return, OR) and trade size. IPOs are classified as cold ($OR \leq 50$ percent), medium ($50 \text{ percent} < OR \leq 150 \text{ percent}$) and large ($OR > 150 \text{ percent}$) based on the opening return relative to the offer price. Similar to the offer size, the volume-to-offer size ratio is increasing in trade size for all underpricing categories. Holding trade size constant, only large trades display an increasing relationship with underpricing. Finally, the volume-to-offer size ratio is significantly higher on day 1 compared to days 2 through 10.

Next, like offer size in Panel A, quoted depths are increasing in trade size across all underpricing groups. However, unlike offer size which increased with the initial return, quoted

⁹ We also investigate the differences in percentage spread across trade size, offer size, and initial returns. The results are qualitatively similar to the results based on quoted spreads; however, the differences among initial return groups become smaller.

depths are decreasing with the initial return, holding trade size constant. For instance, quoted depths for small trades on day 1 are 2.9 million shares for cold IPOs, decreasing to 1.7 million shares for hot IPOs. This may suggest that hot IPOs possibly attract more informed investors (large trades) and therefore investors quote smaller depths to lower the probability of trading with an investor possessing private information. Further, there are no significant differences in quoted depths for cold IPOs between day 1 and days 2 through 10, but quoted depths are significantly larger on day 1 across all trade sizes for warm and hot IPOs.

The last rows in Panel B provide information on quoted spreads. Like Panel A, quoted spreads are increasing in trade size, indicating that large trades consume liquidity. However, while we found that spreads decrease with offer size in Panel A, we find that quoted spreads increase with underpricing. For instance, for small offerings on day 1, quoted spreads are 0.012 RMB, 0.015 RMB, and 0.02 RMB for cold, warm, and hot IPOs, respectively. Thus, there is a higher cost in consuming liquidity for hot IPOs. Again, like the negative relation between quoted depths and underpricing mentioned earlier, the positive relation between quoted spreads and underpricing suggest that hot IPOs likely attract informed trading.

B. Order Aggressiveness and Share Imbalance

When investors trade, they balance the benefit of immediate execution for market orders versus better execution prices and the risk of non-execution for limit orders. The theoretical model of Parlour (1998) suggests that thickness of the limit book affects the probability of order execution and subsequently investors' order placement decisions. The probability of execution for an incoming limit sell order is larger if the book on ask side is thinner and the book on bid side is thicker. The former is obvious since a thinner book on ask side indicates less competition for selling. The latter is less obvious and caused by the "crowding out" effect. The crowding out effect suggests that if the book on bid side is thicker, it induces fewer sellers to submit market sell

orders since sellers rationally anticipate the crowding out of limit buy orders. That is, some buyers will submit market buy orders rather than limit buy orders because of intense competition for buying and low execution probability. Hence, limit sell orders become more attractive. Symmetric conditions hold on the probability of execution for an incoming buy limit order.

In the literature, when both market and limit orders are allowed, market orders are classified as the most aggressive orders, and the aggressiveness of limit orders are determined by whether they are marketable or non-marketable orders. However, in our case, market orders are not allowed. Thus, for a sell order to get executed immediately, the seller needs to submit an aggressive marketable limit sell order with a ask price either matching or even below the best bid price. Similarly, a buyer who wants to buy immediately needs to submit a limit buy order with a bid price either matching or above the current best ask quote. The consolidated trade and quote data compiled by CCER include a buy/sell flag for each trade. Therefore, we are able to use this buy/sell flag to identify the trade direction (buy or sell).

We classify trade aggressiveness by comparing the execution price with the best bid and ask quotes at the time of trade. We classify sells as least aggressive if the highest bid $<$ execution price \leq the lowest ask (i.e., inside-the-quote limit order); moderate aggressive if the execution price $=$ the highest bid; and most aggressive if the execution price $<$ highest bid. Similarly, we categorize buys as least aggressive if the highest bid \leq execution price $<$ the lowest ask; moderate aggressive if the execution price $=$ the lowest ask; and most aggressive if the execution price $>$ the lowest ask.¹⁰

Table 3 presents the results on trade and liquidity supply for each trade group based on offer size. We provide the number of shares at the bid, ask, and order imbalance for each trade category controlling for offer size. In Panel A, we examine trading on day 1. As we observed in

¹⁰ Due to data limitations, canceled orders and orders quoted outside the best bid and ask are not considered in this study. Note also that least aggressive sell and least aggressive buy trades occur when incoming buy and sell orders are matched automatically by the trading system and these orders are not recorded in the limit order book.

Table 2, the number of shares quoted at the bid and ask increases with the number of shares offered, implying large offerings are more liquid. Of greater interest, is that the thickness of the opposite side of the limit order book affects trade aggressiveness. For example, for sell orders, the most aggressive sells occur when the book on the bid side is much smaller than on the ask side, an indication of little buying interest. In this case, a negative share imbalance exists. For the least and moderate aggressive sells, a positive share imbalance occurs. For buy orders, while a positive share imbalance exists for all three execution categories, the book is extremely thin on the ask side for the most aggressive buys, an indication of little selling interest. The share imbalance for the most aggressive buy transactions is over three times the size compared to the least and moderately aggressive buys.

A clearer pattern is shown in Figures 1A, 1C, and 2A. In Figure 1A, the bid side of the limit order book is substantially thinner for aggressive sell orders than for other sell orders, whereas it is not different for buy orders. In sharp contrast, the ask side of limit order book shown in Figure 1C is substantially thinner for aggressive buys than for other buy orders, but it is not different for sell orders. In Figure 2A, the share imbalance associated with aggressive sell orders are negative and the magnitude is substantially larger than that of other seller orders, whereas the share imbalance for aggressive buy orders are positive and much larger than that of other buy orders.

In Panel B, we present the results on days 2 through 10. Although the number of shares quoted is lower than on the first day of trading, a similar pattern emerges. That is, for sell (buy) orders, traders become most aggressive when they observe little buying (selling) interest. Again, a negative share imbalance is observed for the most aggressive sell orders and a large positive share imbalance is observed for the most aggressive buy transactions. These patterns are clearly shown in Figures 1B, 1D, and 2B.

The large share imbalances associated with the most aggressive buy and sell orders suggest that the opposite side of the limit order book reveals important information for traders. When the book on the sell side is extremely thin relative to the book on the bid side, an indication of low selling interest, incoming buyers are willing to pay prices higher than the best ask quote for immediate execution. When the book on buy side is extremely thin, a signal of low buying interest, incoming sellers sell more aggressively for immediate execution. These findings are consistent with Parlour's (1998) theoretical model and further imply that trade immediacy is important for investors in the IPO aftermarket when order imbalance occurs. Although liquidity supply and share imbalance decline dramatically after the first day (see Figures 1 and 2), the association between trade aggressiveness and limit order book thickness observed on day 1 and days 2 and 10 suggest that the effect of information revealed through share imbalance on trade aggressiveness may exist not only for IPO trading, but also for the trading of seasoned securities.

As we previously showed in Panel B of Table 2, quoted depths are negatively related to underpricing. To control for underpricing, we investigate this result further by separating buy and sell orders, depth on both the bid and ask side, and share imbalance by trade aggression within each return group. In Panel A of Table 4, we focus on the first trading day. For cold IPOs, on the bid side, the number of shares for the most aggressive sell orders is substantially lower than the number of shares for the least aggressive and moderate sells, whereas the number of shares for the most aggressive buys is significantly larger than that of the least aggressive buys and moderate buys. Share imbalance is negative for aggressive sells, but positive for aggressive buys and substantially larger than the share imbalance of other buy orders (also see Figure 2C). Similar patterns are observed in warm and hot IPOs. These results suggest that, after controlling for underpricing, investors buy (sell) more aggressively when the ask (bid) side of limit order book is very thin, consistent with the results reported in Table 3.

Similar to the results reported in Panel B of Table 2, the number of shares quoted at bid and ask declines with underpricing in general. For instance, for the least aggressive sell orders, the number of shares quoted at the bid and ask declines with underpricing. For moderate and aggressive sells, there is no significant difference across underpricing groups in the number of shares quoted at the bid, but a negative relationship between underpricing and the number of shares posted at the ask. For buy orders in the least aggressive category, the number of shares posted at the bid is unrelated to underpricing, but negatively related to the number of shares posted at the ask. Similarly, for moderately aggressive buys, a negative relationship exists between the number of shares posted at both bid and ask prices and underpricing, but for the most aggressive buys, no significant differences between underpricing and depth is present. Share imbalance declines for the least and most aggressive sell trade categories as underpricing increases, but increases for moderate sells. In contrast, for the least aggressive buy orders, share imbalance increases with underpricing (also see Figure 2C).

In Panel B of Table 4, we provide results based on trading days 2 through 10. Comparisons made in Panel A are almost identical to those here with respect to quoted depth and share imbalance. That is, for most categories, underpricing is negatively related to depth and share imbalance (also see Figure 2D). The results in Table 4 are consistent with the view that traders quote less for hot IPOs because asymmetric information rises with underpricing and to avoid being taken advantage by an informed party, traders quote less depth.

In Table 5, we examine order aggression and the percentage of trades and volume across underpricing groups. First, as shown in Panel A, the majority of trades for buy and sell orders are moderately aggressive, followed by the most aggressive then least aggressive, regardless of underpricing and whether percentage of trade or volume is used as a measure. Most buyers (sellers) submit marketable limit buy (sell) orders that match the best quotes on the opposite of limit order book. Second, as underpricing increases so does the percentage of aggressive trades,

both for buy and sell orders. Third, the results are similar in the days following the IPO (Panel B). That is, underpricing is correlated to the percentage of trades and volume beyond the IPO date. Thus, underpricing or some other factor(s) correlated with underpricing continues to influence trade aggression subsequent to the first day of trading.

C. *Multivariate models*

In table 6 we examine the determinants of limit order depth at the bid and ask separately using OLS techniques for day 1 and days 2 to 10. The model takes the form:

$$\begin{aligned} \text{Log (Depth)} = & \alpha_0 + \alpha_1 (\text{Age}) + \alpha_2 (\text{Log Assets}) + \alpha_3 (\text{Log gov't shares}) \\ & + \alpha_4 (\text{Top 5 Owners}) + \alpha_5 (\text{PE ratio}) + \alpha_6 (\text{Log Shares offered}) + \alpha_7 \\ & (\text{Risk Factors}) + \alpha_8 (\text{Offer ratio}) + \alpha_9 (\text{Underpricing}) + \alpha_{10} (\text{Turnover}) \\ & + \alpha_{11} (\text{Aggressive buy/sell}) + \varepsilon, \end{aligned} \quad (1)$$

where the dependent variables are the natural log of bid and ask depth. The independent variables include firm and IPO characteristics and trading-related variables. First, we include the age of the firm in years and the natural log of assets as of the quarter end before the IPO date. Both these variables are used to gauge firm-specific information asymmetries. Older and larger firms are expected to have less information asymmetry problems and therefore we expect more shares to be quoted on both the bid and ask sides. We include the natural log of the number of shares the government holds (gov't shares) and the percentage of firms held by the top 5 owners (Top 5 owners) before the time of the IPO as additional control variables. Bid depth is likely to be negatively related to higher ownership percentages because the probability of trading with insiders of the firm is increased. We add PE ratio to our model, but the effect is likely ambiguous. Although the PE ratio typically measures growth options of a firm and information asymmetry rises with growth options, China law dictates a ceiling on PE ratios at the time of the IPO. Thus, any relationship is likely to be muted by the truncation imposed by the government.

The next four variables are IPO-related attributes. Like the natural log of assets, the natural log of shares offered is expected to be positively related to both bid and ask depth. Risk factors are the number of risk factors mentioned in the IPO prospectus. On one hand, disclosing more risk factors might alleviate more information asymmetries, but at the same time it could signal a riskier offering and potentially less incentive to provide liquidity. Offer ratio is the number of shares offered in the IPO scaled by the number of shares demanded through the lottery. If demand is high in the lottery, we might expect continued demand in the aftermarket and therefore depth, particularly on the bid side to be positively related to the offer ratio. Underpricing is defined as the percentage difference between the opening price and offer price. In Table 4 we found a negative relationship between depth and underpricing. We investigate if this result holds after controlling for other factors.

The final variables included in the model are trading-related variables. Turnover is daily volume divided by the number of shares outstanding after the IPO. Any volume-related proxy is expected to be positive on both sides of the bid and ask since more volume implicitly assumes more liquidity. Finally, aggressive buy/sell is a dummy variable and is expected to be negatively related to ask depth for buy orders and bid depth for sell orders.

Panel A reports results for buy orders and Panel B reports sell orders. Age is positively related to bid and ask depth on day 1 and days 2 through 10. Since age is a proxy for firm-specific asymmetric information, this implies that traders are willing to post more shares for older firms presumably because there are less information asymmetry problems. While the natural log of assets has a similar interpretation in that larger firms should be associated with lower degrees of asymmetric information, the results are mixed. Assets are negatively significant for bid depth on day 1 and positive and significant for ask depth on days 2 through 10. The natural log of government shares is positive and significantly related to depth on both sides and for both day 1 and days 2 through 10. Thus, traders are willing to quote more shares when the government has a

bigger ownership position. On the other hand, when ownership is concentrated, one would expect less shares to be quoted for fear of being exploited by insiders. However, we find the coefficient on the Top 5 Owners to be positive in all specifications, and significant at the 5 percent level on day 1 bid depth. The PE ratio is negative and significant in all models. Although the PE ratio capped by the government, a strong relationship still is found. Thus, traders are reluctant to post more shares for firms with more growth options (i.e., high information asymmetry).

The number of shares offered is positively related to depth on day 1 and days 2 through 10, confirming our previous results that the size of offering influences liquidity. The number of risk factors in the prospectus is positively related to bid depth on day 1 and both bid and share depth on days 2 through 10. This suggests that more disclosure mitigates traders concerns and they are more willing to quote more shares. The offer ratio is positively related to ask depth on days 1, but reverses and is negatively related to both bid and ask depth on days 2 through 10. Consistent with the results in Tables 2 and 4, once we control for other firm-level and IPO characteristics, underpricing is negatively related to ask depth on day 1 and both bid and ask depth on days 2 through 10.

As expected, share turnover is positive and highly significant in all four models indicating more volume, more shares quoted. Finally, the aggressive buy dummy is negative and significant on day 1 for ask depth, but insignificant for bid depth. These results reiterate that the book on the ask side provides potential buyers a stronger signal than the book on the bid side. IPO investors buy more aggressively when the book on ask side is thin. On days 2 through 10, however, both sides of the limit order book are significant, suggesting both a thick bid and thin ask to encourage traders to become aggressive.

Panel B presents the results for sell orders. The relationships in Panel B essentially mirror those found in Panel A. The only exception is here we dummy in for aggressive sell orders instead of aggressive buy orders. Thus, the signs are reversed, but the interpretation remains

intact. That is, on day 1, the coefficient on the aggressive sell dummy variable is negative and significant on the bid side, but insignificant on the ask side. Thus, a thin book on the bid side induces traders to become more aggressive, but ask depth is not related to trade aggressiveness. On day 1 and days 2 through 10, both the bid and ask side reveal important information related to traders' aggression.

In Table 7, we further investigate how the thickness of the limit order book affects investors' order placement decisions. We run Probit regressions where the dependent variables equal 1 for the most aggressive buy (sell) orders in buy (sell) regressions and 0 otherwise. The independent variables are the same as in Table 6 with a few exceptions. We include the natural log of shares posted at the bid and ask prices and the quoted spread at the time of the transaction since we expect that both depths and spreads affect investor's trade aggressiveness

Focusing on the trading-related variables introduced in this specification, for buy orders on both day 1 and days 2 through 10, the coefficients on Log (Shares at bid) are positive and significant at the 1 percent level, whereas all the coefficients on Log (Shares at ask) are negative and similarly significant. These results provide additional evidence that potential buyers submit more aggressive orders when the book is thin on the sell side and thick on the buy side. Further, quoted spreads are negative and significant at the 1 percent level. This suggests that investors buy more aggressively when spreads are tight.

For sell orders, traders sell more aggressively when the book is thin on the bid side and thick on the ask side, opposite to that of buy orders. Also, consistent with the results found on the buy side, traders are more aggressive when quoted spreads are smaller.

Note also that the coefficients on Opening Return in the buy regressions are insignificant on day 1, but positive and significant for sell orders. This pattern reverses on days 2 through 10 in that underpricing is positively related to buy aggressiveness, but not to selling behavior.

IV. Conclusions

Previous studies show that lead underwriters and their associated dealers play an important role in the IPO early aftermarket trading by taking various actions to balance the demand for and supply of the newly issued shares. In the current study, we examine IPO trading, liquidity supply and evolution in order-driven markets, where no designated market makers exist, underwriter price supports are not available, and market orders are not allowed.

In our sample of Chinese IPOs from August 1999 to December 2005, consistent with previous studies in the US and elsewhere, IPO trading is extremely active on the first day of trading, regardless of the initial return, but dissipates sharply after a few days and reaches a stable level around the 10th trading day. Large trades dominate the first day trading and this dominant role is more pronounced in larger offerings and high initial return IPOs. After the first trading day, small trades prevail in all IPOs.

We find the quoted depths in the limit order book mimic the trade pattern in the IPO aftermarket and are positively correlated with trade size, offer size and negatively related to initial returns. These results indicate that information asymmetry is severe for smaller and high initial return IPOs and traders are reluctant to post higher amounts fearing exploitation by informed traders.

Execution immediacy is important in IPO aftermarket trading. To obtain immediate transactions, IPO investors submit aggressive marketable limit orders that are better than the best quotes on the opposite of the limit order book. The thickness of limit order book provides important information to investors and influences their trading behavior. IPO investors buy more aggressively when the book on the ask side is thin and when order imbalance is large, an indication of low (or no) interest in selling. In contrast, investors sell more aggressively when the book on bid side is very thin and when order imbalance is negative, a signal of low interest in

buying. Finally, spreads influence IPO investors trade aggressiveness. IPO investors buy and sell more aggressively when spreads are tight.

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Table 1: Descriptive Statistics of IPO Offering

Panel A: Offering and firm statistics of the whole sample (N = 506)				
Variable	Mean	Median	Minimum	Maximum
Offer price (RMB)	8.0	7.2	1.0	36.7
Shares offered	101.3	50.0	9.1	5,000.0
Shares in circulation	83.0	45.2	3.0	2,750.0
Offer ratio (%)	0.4	0.2	0.0	5.7
PE ratio	24.2	20.0	1.6	88.7
Risk factor (#)	19.2	18.0	4.0	54.0
Shares before IPO	460.1	100.3	12.5	83,902.4
State shares	363.8	68.9	0.0	67,122.0
Shares after IPO	561.4	155.5	50.0	86,702.4
Invitation time before	28.1	20.0	9.0	213.0
Invitation Period	11.2	8.0	1.0	92.0
1 st day opening return	121.0%	100.0%	-4.0%	3,500.0%
1 st day closing return	124.0%	100.0%	-9.0%	3,300.0%
Panel B: Aftermarket trade and quote summary statistics				
Day 1 volume (000 shares)	37,551.9	25,530.3	375.4	1,164,272.5
Days 2 to 10 volume (000 shares)	5,666.5	2,905.1	96.3	202,493.0
Day 1 trade size (000 shares)	88.7	23.3	1.0	10,663.0
Days 2 to 10 trade size (000 shares)	9.3	3.7	0.6	1,590.0
Day1 quoted depths (000 shares)	6,325.5	2,897.8	405.3	214,912.8
Days 2 to 10 quoted depths (000 shares)	3,228.5	1,014.6	160.5	467,446.0
Day 1 quoted spread (RMB)	0.022	0.018	0.010	0.181
Days 2 to 10 quoted spread (RMB)	0.021	0.017	0.010	0.231

Shares in circulation is the number of shares that is publicly tradable. *Offer ratio* is the total number of shares offered divided by the total number of shares demanded by investors through lottery. *PE ratio* is offer price divided by the earnings per share prior to the offering. *Risk factor* is the number of risks mentioned in issuing firms' Prospectus. *State shares before* is the number of shares owned by the central and local government agencies before the IPO. *Invitation begin prior to IPO* is the number of days that invitation for share purchase begins prior to the offering date. *Invitation period* is the total number of days that invitation lasts. *The 1st day opening return* is calculated as (the 1st day opening price – offer price)/offer price. *The 1st day closing return* is computed as (the 1st day closing price – offer price)/offer price. *Quoted depths* are the number of shares quoted at the highest bid price and the lowest ask price. *Quoted spread* is the difference between the highest ask price and the lowest bid price measured in Chinese currency (RMB). Other variables are self-explanatory.

Table 2: Descriptive Statistics of IPO Aftermarket Trade and Quote

Panel A: Aftermarket Trade and Quote based on Offer Size									
Trade size	Small			Medium			Large		
	Day 1	Days 2 to10	<i>p</i>	Day 1	Days 2 to10	<i>p</i>	Day 1	Days 2 to10	<i>p</i>
<i>Volume-to-Offer Size Ratio (%)</i>									
Small	9.44	3.98	0.00	4.04	2.70	0.00	1.45	1.57	0.03
Medium	9.50	0.87	0.00	7.99	0.93	0.00	4.86	0.87	0.00
Large	23.14	0.67	0.00	31.20	0.70	0.00	31.77	1.01	0.00
<i>Quoted Depths (000 shares)</i>									
Small	1,445.1	662.5	0.00	2,349.0	985.0	0.00	3,614.7	1,749.3	0.01
Medium	2,452.7	1,104.0	0.00	3,235.4	1,523.0	0.00	5,121.5	2,536.8	0.02
Large	4,015.9	1,670.0	0.00	5,072.1	2,047.0	0.00	7,529.4	3,738.6	0.02
<i>Quoted Spread (000 RMB)</i>									
Small	0.018	0.022	0.00	0.015	0.016	0.001	0.013	0.013	0.26
Medium	0.029	0.027	0.04	0.018	0.020	0.05	0.015	0.015	0.12
Large	0.052	0.027	0.00	0.030	0.021	0.02	0.020	0.015	0.00
Panel B: Aftermarket Trade and Quote based on 1 st Day Opening Return									
Trade size	Cold			Warm			Hot		
	Day 1	Days 2 to10	<i>p</i>	Day 1	Days 2 to10	<i>p</i>	Day 1	Days 2 to10	<i>p</i>
<i>Volume-to-Offer Size Ratio (%)</i>									
Small	7.05	2.45	0.00	3.63	2.54	0.00	4.27	2.69	0.00
Medium	6.91	0.87	0.00	7.26	0.94	0.00	7.98	0.82	0.00
Large	14.85	0.87	0.00	29.71	0.78	0.00	38.03	0.78	0.00
<i>Quoted Depths (000 shares)</i>									
Small	2,902.2	1,359.3	0.27	2,227.1	1,004.1	0.00	1,714.0	729.5	0.00
Medium	3,881.2	2,048.5	0.23	3,419.6	1,629.9	0.00	2,782.2	1,203.7	0.00
Large	6,235.2	3,908.8	0.45	5,262.2	2,394.4	0.00	4,692.0	1,520.0	0.00
<i>Quoted Spread (000 RMB)</i>									
Small	0.012	0.014	0.14	0.015	0.016	0.01	0.020	0.023	0.01
Medium	0.017	0.016	0.01	0.018	0.020	0.96	0.027	0.027	0.58
Large	0.024	0.015	0.00	0.030	0.020	0.00	0.048	0.026	0.00

To control for the effects of offer size (i.e., the number of shares offered –*NSO*) and the 1st day opening return (*OR*) on IPO secondary market trades and quotes, we divide the whole sample into three groups based on *NSO* and the 1st opening return, respectively. For offer size groups (of approximately the same size), *Small*: $NSO \leq 40,000$; *Medium*: $40,000 < NSO \leq 60,000$; and *Large*: $NSO > 60,000$. For the 1st day opening return groups: *Cold*: $OR \leq 50\%$; *Warm*: $50\% < OR \leq 150\%$; and *Hot*: $OR > 150\%$. For each stock, all trades are classified into three groups based on trade size. *Small*: trade size $\leq 10,000$ shares; *Medium*: $10,000 < \text{trade size} \leq 50,000$ shares; and *Large*: trade size $> 50,000$ shares. *Volume-to-Offer ratio* is the daily trading volume of a given trade size group divided by the total number of shares offered for that stock. *Quoted spread* is the difference between the lowest ask and the highest bid prices in Chinese currency (RMB). *Quoted Depth* is the total number of shares quoted at bid and ask prices. To reduce the impact of outliers, we report the median values. To investigate the changes in trade and quote in the IPO aftermarket, we compare the test variables on day 1 and days 2 to 10, and conduct t-tests. P-values of t-tests are reported.

Table 3: Trade Aggressiveness and Limit Order Book Thickness Across Offering Size Groups

Panel A: Shares (000) at Bid and Ask and Share Imbalance on Day 1									
	Offer Size Groups								
	Small			Medium			Large		
<i>Sell Orders</i>	Bid	Ask	Imbalance	Bid	Ask	Imbalance	Bid	Ask	Imbalance
Least Aggressive	1,202.2	803.8	348.5	2,060.2	1,342.0	565.7	3,214.1	2,751.3	587.0
Moderate	1,205.8	682.3	433.1	1,897.0	1,227.4	477.5	3,056.3	2,427.3	497.0
Most Aggressive	278.3	796.6	-514.5	460.8	1,329.6	-834.2	685.2	2,756.8	-2,010.3
<i>Buy Orders</i>	Bid	Ask	Imbalance	Bid	Ask	Imbalance	Bid	Ask	Imbalance
Least Aggressive	1,191.8	797.4	278.6	2,169.5	1,358.4	607.6	3,383.2	2,704.2	414.0
Moderate	966.3	851.0	159.8	1,645.7	1,336.3	268.0	2,958.5	2,564.2	535.4
Most Aggressive	1,267.2	252.3	971.8	2,036.1	414.6	1,599.9	3,525.6	682.4	2,869.1
Panel B: Shares (000) at Bid and Ask and Imbalance on Days 2-10									
<i>Sell Orders</i>	Bid	Ask	Imbalance	Bid	Ask	Imbalance	Bid	Ask	Imbalance
Least Aggressive	378.2	299.3	69.3	605.1	491.4	102.0	1,196.1	882.1	226.6
Moderate	399.3	314.0	66.0	582.9	498.7	54.2	1,027.7	909.8	62.9
Most Aggressive	122.0	333.9	-206.0	178.7	544.3	-362.9	272.3	1,006.0	-720.6
<i>Buy Orders</i>	Bid	Ask	Imbalance	Bid	Ask	Imbalance	Bid	Ask	Imbalance
Least Aggressive	342.3	321.4	12.1	565.5	514.5	43.5	1,059.4	927.1	73.1
Moderate	348.7	370.5	-15.3	556.8	573.8	0.8	1,078.2	974.4	163.4
Most Aggressive	385.7	123.4	254.8	621.2	178.3	424.2	1,236.8	281.4	902.7

Stocks are first divided into three groups of approximately the same size based on offering size (i.e., the number of shares offered in IPO). Then, the mean and median values of shares quoted at bid price, at ask price, and share imbalance (i.e., shares at bid minus shares at ask) are computed for each sell and buy group within each offering group. To reduce the impact of outliers, we report median values only. Sell orders are classified as *Least Aggressive* if highest bid < sell price ≤ lowest ask, *Moderate* if sell price = highest bid, and *Most Aggressive* if sell price < highest bid. Buy orders are classified as *Least Aggressive* if highest bid ≤ buy price < lowest ask, *Moderate* if buy price = lowest ask, and *Most Aggressive* if buy price > lowest ask.

Table 4: Trade Aggressiveness and Limit Order Book Thickness Across the 1st Opening Return Groups

Panel A: Shares (000) at Bid and Ask and Share Imbalance on Day 1									
	1 st Day Opening Return Groups								
	Cold			Warm			Hot		
<i>Sell Orders</i>	Bid	Ask	Imbalance	Bid	Ask	Imbalance	Bid	Ask	Imbalance
Least Aggressive	2,072.0	1,495.3	549.2	2,054.3	1,351.3	414.5	1,699.8	1,138.0	353.7
Moderate	1,950.6	1,712.6	176.2	1,943.9	1,237.7	477.5	1,884.3	827.4	880.0
Most Aggressive	361.3	1,680.8	-1,337.2	432.5	1,351.5	-856.4	410.9	1,065.5	-551.3
<i>Buy Orders</i>									
Least Aggressive	1,853.4	1,676.7	127.7	1,966.7	1,428.5	424.2	1,910.4	1,057.0	537.8
Moderate	1,950.2	1,658.7	461.8	1,650.0	1,339.0	201.7	1,319.0	1,158.3	57.1
Most Aggressive	2,083.4	353.1	1,648.4	1,968.5	396.4	1,546.4	1,725.9	356.8	1,345.8
Panel B: Shares (000) at Bid and Ask and Share Imbalance on Days 2-10									
<i>Sell Orders</i>									
Least Aggressive	831.6	560.0	206.1	615.2	478.9	105.2	417.1	386.4	22.5
Moderate	752.4	680.8	52.7	595.3	498.5	59.9	445.9	351.1	70.8
Most Aggressive	216.7	712.5	-480.9	176.6	530.0	-350.2	129.3	382.7	-251.5
<i>Buy Orders</i>									
Least Aggressive	657.9	670.0	-24.8	554.9	507.0	36.8	425.2	353.8	58.2
Moderate	812.2	694.0	105.7	571.2	567.0	22.1	377.0	445.5	-47.4
Most Aggressive	845.7	213.2	630.6	628.2	176.5	437.8	436.1	129.7	293.3

Stocks are first divided into three groups based on the 1st day opening return (*OR*), *Cold*: $OR \leq 50\%$; *Warm*: $50\% < OR \leq 150\%$; and *Hot*: $OR > 150\%$. Then, the mean and median values of shares quoted at bid price, at ask price, and share imbalance (i.e., shares at bid minus shares at ask) are computed for each sell and buy group within each return group. To reduce the impact of outliers, we report median values only. Sell orders are classified as *Least Aggressive* if highest bid < sell price \leq lowest ask, *Moderate* if sell price = highest bid, and *Most Aggressive* if sell price < highest bid. Buy orders are classified as *Least Aggressive* if highest bid \leq buy price < lowest ask, *Moderate* if buy price = lowest ask, and *Most Aggressive* if buy price > lowest ask.

Table 5: Percentage of Trade Across Trade Aggressive and the 1st Opening Return Groups

Panel A: Percentage of Trade (%of Trade) and Percentage of Volume (% of Vol.) on Day 1						
	1 st Day Opening Return Groups					
	Cold		Warm		Hot	
<i>Sell Orders</i>	% of trade	% of Vol.	% of trade	% of Vol.	% of trade	% of Vol.
Least Aggressive	0.032	0.034	0.039	0.038	0.048	0.047
Moderate	0.419	0.306	0.358	0.247	0.271	0.188
Most Aggressive	0.109	0.172	0.150	0.216	0.185	0.252
<i>Buy Orders</i>						
Least Aggressive	0.046	0.051	0.049	0.052	0.057	0.056
Moderate	0.301	0.243	0.282	0.214	0.264	0.183
Most Aggressive	0.076	0.154	0.113	0.189	0.159	0.250
Panel B: Percentage of Trade (%of Trade) and Percentage of Volume (% of Vol.) on Days 2-10						
<i>Sell Orders</i>						
Least Aggressive	0.031	0.021	0.035	0.024	0.038	0.027
Moderate	0.405	0.324	0.370	0.287	0.334	0.239
Most Aggressive	0.082	0.171	0.111	0.209	0.145	0.249
<i>Buy Orders</i>						
Least Aggressive	0.036	0.024	0.041	0.028	0.046	0.032
Moderate	0.357	0.292	0.338	0.266	0.317	0.241
Most Aggressive	0.062	0.118	0.084	0.145	0.109	0.173

Stocks are first divided into three groups based on the 1st day opening return, *Cold*: opening return $\leq 50\%$; *Warm*: $50\% < \text{opening return} \leq 150\%$; and *Hot*: opening return $> 150\%$. Trades are classified based on the aggressiveness. Sell orders are classified as *Least Aggressive* if highest bid $< \text{sell price} \leq \text{lowest ask}$, *Moderate* if sell price = highest bid, and *Most Aggressive* if sell price $< \text{highest bid}$. Buy orders are classified as *Least Aggressive* if highest bid $\leq \text{buy price} < \text{lowest ask}$, *Moderate* if buy price = lowest ask, and *Most Aggressive* if buy price $> \text{lowest ask}$. For each firm, we count the number of trades of each trade category (i.e., from least aggressive sell to most aggressive buy) and divide it by the total number of trades per day to get % of trade. Similarly, we also compute the daily trade volume of each trade category and divide it by the firm's daily total volume to get % of Vol. Then, we calculate the mean and median values of % of trade and % of Vol. for each sell and buy group within each return group. To reduce the impact of outliers, we report median values only.

Table 6: Regression of Shares Quoted at Bid and Ask Prices

Panel A: Buy Orders				
Ind. Variables	Log (Bid Depth)		Log (Ask Depth)	
	Day 1	Days 2 to10	Day 1	Days 2 to10
Intercept	-7.575 (-13.11 ^{***})	-10.967 (-61.33 ^{***})	-7.487 (-16.44 ^{***})	-9.300 (-55.63 ^{***})
<i>Firm characteristics</i>				
Age	0.018 (2.33 ^{**})	0.014 (5.91 ^{***})	0.014 (2.33 ^{**})	0.009 (4.00 ^{***})
Log (Asset)	-0.071 (-1.91 [*])	0.006 (0.55)	-0.010 (-0.32)	0.051 (4.78 ^{***})
Log (gov't. shares)	0.033 (3.12 ^{***})	0.034 (10.50 ^{***})	0.027 (3.29 ^{***})	0.028 (9.16 ^{***})
% Top5owners	0.321 (2.20 ^{**})	0.040 (0.88)	0.080 (0.69)	0.010 (0.24)
PE ratio	-0.009 (-5.15 ^{***})	-0.012 (-21.01 ^{***})	-0.004 (-2.51 ^{**})	-0.010 (-19.18 ^{***})
<i>IPO characteristics</i>				
Log(Shares offered)	0.902 (19.26 ^{***})	0.965 (67.08 ^{***})	0.823 (22.27 ^{***})	0.816 (60.69 ^{***})
Risk factors	0.007 (2.42 ^{**})	0.012 (12.23 ^{***})	-0.001 (-0.24)	0.009 (11.00 ^{***})
Offer ratio	-0.019 (-0.57)	-0.079 (-7.98 ^{***})	0.202 (7.86 ^{***})	-0.089 (-8.97 ^{***})
Opening return	-0.010 (-0.38)	-0.130 (-16.08 ^{***})	-0.062 (-2.96 ^{***})	-0.090 (-11.90 ^{***})
<i>Trading variables</i>				
Turnover day t	6.070 (6.17 ^{***})	34.365 (34.60 ^{***})	9.997 (12.87 ^{***})	52.208 (56.22 ^{***})
Aggressive buy	0.041 (1.07)	0.104 (9.23 ^{***})	-1.385 (-45.44 ^{***})	-1.140 (-108.5 ^{***})
Adj-R ²	0.519	0.648	0.771	0.722

Table 6 (continued)

Panel B: Sell Orders				
Ind. Variables	Log (Bid Depth)		Log (Ask Depth)	
	Day 1	Days 2 to10	Day 1	Days 2 to10
Intercept	-8.274 (-16.62 ^{***})	-9.521 (-57.37 ^{***})	-8.673 (-18.48 ^{***})	-10.472 (-60.36 ^{***})
<i>Firm characteristics</i>				
Age	0.007 (1.10)	0.012 (5.58 ^{***})	0.019 (2.97 ^{***})	0.008 (3.61 ^{***})
Log (Asset)	0.073 (2.26 ^{**})	0.024 (2.26 ^{**})	-0.084 (-2.78 ^{***})	0.031 (2.85 ^{***})
Log(gov't. shares)	0.014 (1.58)	0.023 (7.59 ^{***})	0.034 (3.98 ^{***})	0.039 (12.29 ^{***})
% Top5owners	0.125 (1.00)	0.017 (0.40)	0.302 (2.57 ^{**})	0.032 (0.73)
PE ratio	-0.005 (-3.04 ^{***})	-0.012 (-22.37 ^{***})	-0.004 (-2.47 ^{**})	-0.011 (-19.31 ^{***})
<i>IPO characteristics</i>				
Log(Shares offered)	0.788 (19.78 ^{***})	0.879 (65.36 ^{***})	0.964 (25.66 ^{***})	0.897 (64.45 ^{***})
Risk factors	0.007 (2.68 ^{***})	0.011 (12.91 ^{***})	-0.001 (-0.37)	0.009 (10.21 ^{***})
Offer ratio	0.032 (1.16)	-0.096 (-10.44 ^{***})	0.162 (6.18 ^{***})	-0.038 (-3.94 ^{***})
Opening return	0.033 (1.48)	-0.118 (-15.83 ^{***})	-0.112 (-5.32 ^{***})	-0.097 (-12.46 ^{***})
<i>Trading variables</i>				
Turnover day <i>t</i>	11.19 (13.92 ^{***})	38.71 (42.04 ^{***})	5.433 (7.17 ^{***})	46.299 (48.01 ^{***})
Aggressive Sell	-1.608 (-49.87 ^{***})	-1.302 (-124.19 ^{***})	0.007 (0.24)	0.037 (3.36 ^{***})
Adj-R ²	0.758	0.744	0.690	0.654

Dependent variables are log of number of shares quoted at bid and ask, respectively. Independent variables include (1) firm characteristics--firm age (*Age*) and total asset at the time of IPO (*Log (Asset)*), the number of shares owned by state governments (*Log (gov't. shares)*) before the IPO, proportion of shares owned by the top five owners (*% Top5owners*) before the IPO, the ratio of offer price to earnings per share prior to IPO (*PE ratio*); (2) IPO characteristics--log # of shares offered (*Log (Shares offered)*), # of risk factors mentioned in Prospectus (*Risk factors*), the ratio of number of shares offered to the number of shares demanded through lottery (*Offer ratio*), and the 1st day opening return (*Opening return*), which is computed as (Opening price – offer price)/offer price; (3) Trading activity variable--turnover ratio (*Turnover*), which is computed as the total daily trading volume divided by the number of shares outstanding after IPO; (4) a dummy variable--*Aggressive Buy (Sell)* equals to 1 if a trade is classified as the most aggressive buy (sell) and 0 otherwise. T-stat is reported in parentheses. ^{***}, ^{**}, and ^{*} indicate significance at 0.01, 0.05, and 0.10 levels, respectively. Panel A reports the regressions for Buy Orders, whereas Panel B reports the regressions for Sell Orders.

Table 7: Probit Regression on Trade Aggressiveness

Ind. Variables	Panel A: Buy Orders		Panel B: Sell Orders	
	Day 1	Days 2 to10	Day 1	Days 2 to10
Intercept	-28.809 (-8.84 ^{***})	-10.280 (-14.01 ^{***})	-26.115 (-7.59 ^{**})	-11.814 (-13.13 ^{***})
<i>Firm characteristics</i>				
Age	-0.037 (-1.06)	-0.011 (-1.40)	-0.025 (-0.68)	-0.003 (-0.27)
Log (Asset)	0.634 (4.27 ^{***})	0.265 (7.05 ^{***})	0.617 (3.64 ^{***})	0.144 (3.14 ^{***})
Log (gov't. shares)	-0.006 (-0.13)	-0.001 (-0.13)	-0.047 (-0.89)	-0.030 (-2.26 ^{**})
% Top5owners	0.457 (0.69)	0.184 (1.18)	1.321 (1.82 ^{**})	0.249 (1.37)
PE ratio	0.019 (2.08 ^{**})	-0.000 (-0.09)	0.005 (0.61)	-0.007 (-2.85 ^{***})
<i>IPO characteristics</i>				
Log(Shares offered)	1.768 (7.13 ^{***})	0.666 (11.54 ^{***})	1.460 (5.16 ^{***})	0.974 (13.43 ^{***})
Risk factors	0.009 (0.70)	0.009 (3.00 ^{***})	0.029 (2.10 ^{**})	0.020 (5.23 ^{***})
Offer ratio	0.299 (1.69 [*])	-0.109 (-2.84 ^{***})	-0.231 (-1.72 [*])	-0.148 (-3.47 ^{***})
Opening return	0.004 (0.05)	0.068 (2.48 ^{**})	0.465 (3.69 ^{***})	-0.022 (-0.64)
<i>Trading variables</i>				
Turnover day <i>t</i>	70.639 (10.80 ^{***})	90.733 (25.83 ^{***})	57.050 (9.93 ^{***})	69.014 (15.64 ^{***})
Log(Shares at bid)	0.856 (6.96 ^{***})	1.186 (35.64 ^{***})	-3.366 (-17.58 ^{***})	-3.017 (-65.78 ^{***})
Log(Shares at ask)	-3.558 (-17.06 ^{***})	-2.527 (-66.35 ^{***})	1.142 (7.37 ^{***})	1.471 (34.98 ^{***})
Quoted Spread	-32.856 (-6.48 ^{***})	-32.151 (-21.33 ^{***})	-25.042 (-4.62 ^{***})	-37.994 (-21.86 ^{***})

For buy (sell) order regressions in Panel A (Panel B), the dependent variables equal 1 if a buy (sell) order is classified as the most aggressive buy (sell) order in buy (sell) regressions. Independent variables include (1) firm characteristics--firm age (*Age*) and total asset at the time of IPO (*Log (Asset)*), the number of shares owned by state governments (*Log (gov't. shares)*) before the IPO and proportion of shares owned by the top five owners (*% Top5owners*) before the IPO, offer price to earnings per share prior to IPO (*PE ratio*); (2) IPO characteristics--log # of shares offered (*Log (Shares offered)*), # of risk factors mentioned in Prospectus (*Risk factors*), the number of shares offered to the number of shares demanded through lottery (*Offer ratio*), and the 1st day opening return (*Opening return*); (3) Trade and quote variables--turnover ratio (*Turnover*), i.e., total daily trading volume divided by the number of shares outstanding after IPO; *Quoted spreads*, the number of shares quoted at bid (*Log(Shares at Bid)*) and ask (*Log(Shares at ask)*). ***, **, and * indicate significance at 0.01, 0.05, and 0.1 levels, respectively.

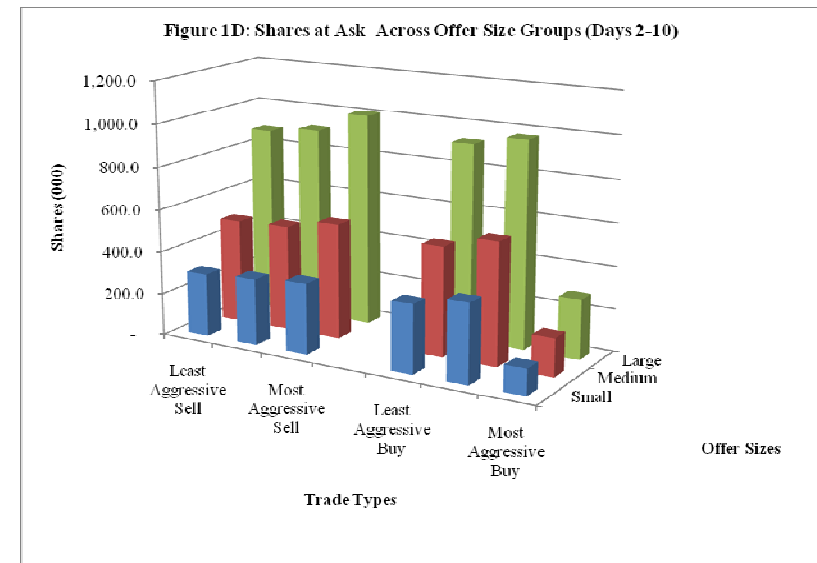
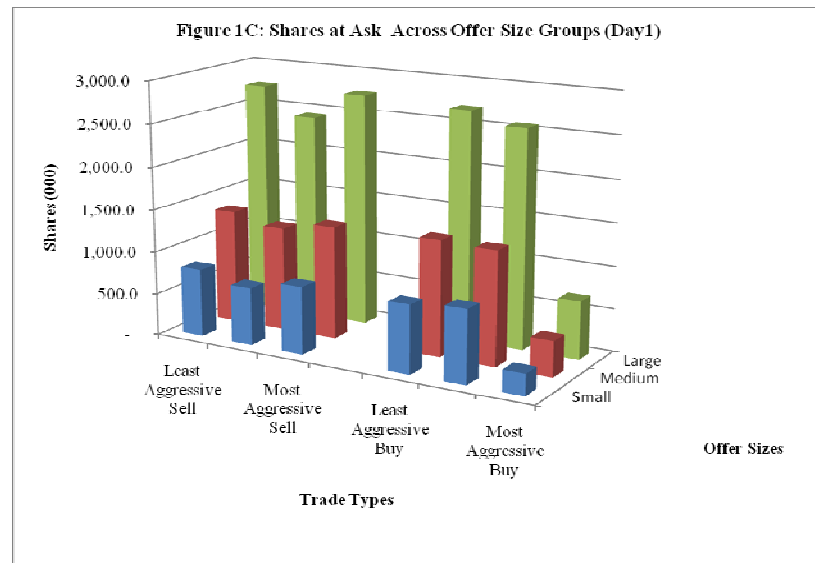
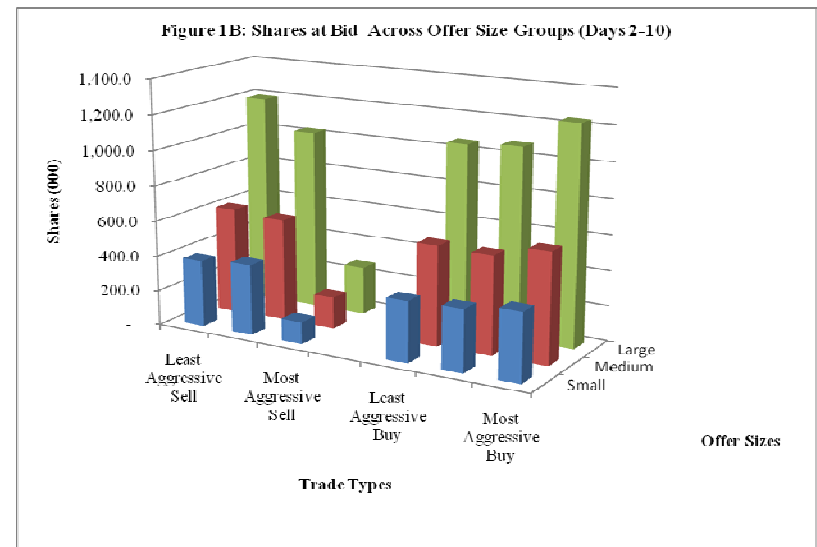
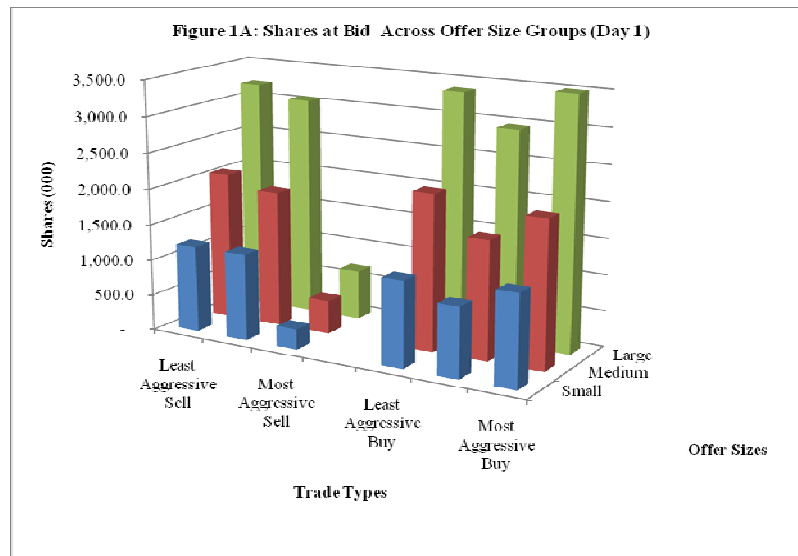


Figure 2A: Share Imbalance Across Offer Size Groups (Day1)

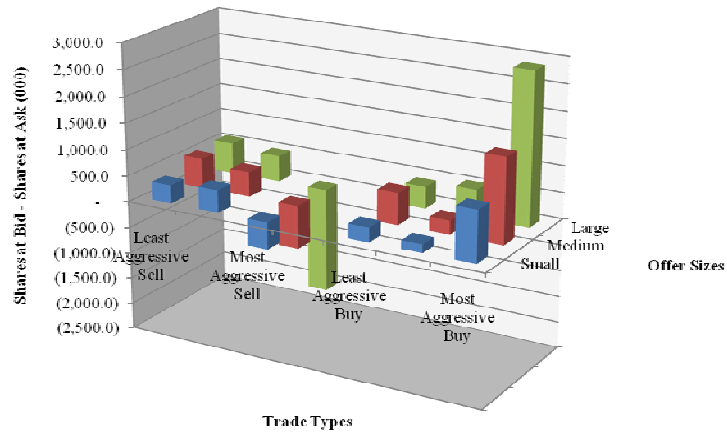


Figure 2B: Share Imbalance Across Offer Size (Days 2-10)

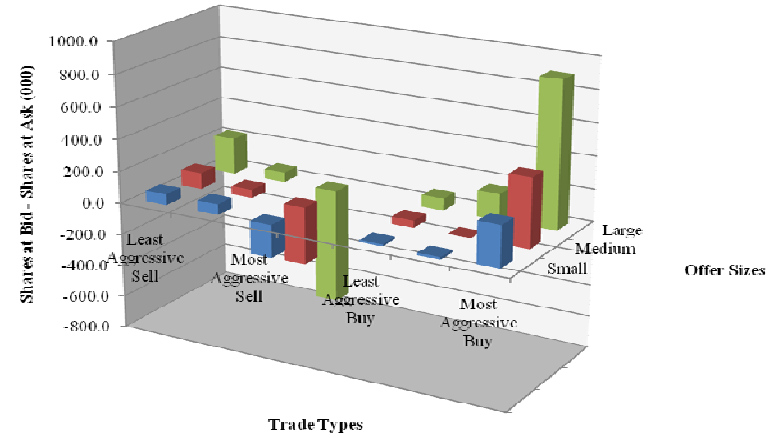


Figure 2C: Share Imbalance Across 1st Day Opening Return Groups (Day1)

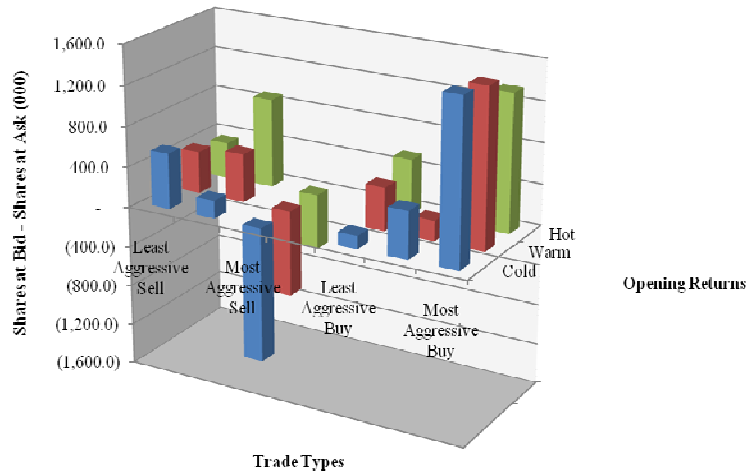


Figure 2D: Share Imbalance Across 1st Day Opening Return Groups Days 2-10)

